Image upconversion - a low noise infrared sensor?

Dam, Jeppe Seidelin; Tidemand-Lichtenberg, Peter; Pedersen, Christian

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Jeppe Seidelin Dam, Peter Tidemand-Lichtenberg, and Christian Pedersen

Abstract
Low noise upconversion of IR images by three-wave mixing, can be performed with high efficiency when mixing the object radiation with a powerful laser field inside a highly non-linear crystal such as periodically poled Lithium Niobate. Since IR cameras are expensive and have high levels of intrinsic noise, we suggest to convert the wavelength from the mid infrared to the visible/NIR wavelength for simple detection using CCD cameras. The intrinsic noise in cameras has two main contributions. First, read noise originating from the charge to signal read-out electronics. This noise source is usually measured in number of electrons. The second noise source is usually referred to as dark noise, which is the background signal generated over time. Dark noise is usually measured in electrons per pixel per second. For silicon cameras certain models like EM-CCD have close to zero read noise, whereas high-end IR cameras have read noise of hundreds of electrons. The dark noise for infrared cameras based on semiconductor materials is also substantially higher than for silicon cameras, typical values being thousands of electrons per pixel per second for cryogenically cooled cameras. An ideal solution thus suggest the combination of an efficient low noise image wavelength conversion system combined with low noise silicon based cameras for low noise imaging in the IR region. We discuss image upconversion as a means to do low noise conversion of IR light to visible light. We demonstrate system noise performance orders of magnitude lower than existing cryogenic cooled IR cameras.

Summary
Low noise upconversion of IR images by three-wave mixing, can be performed with high efficiency when mixing the object with a powerful laser field inside a highly non-linear crystal such as periodically poled Lithium Niobate. This feature effectively allows the use of silicon based cameras for detection of infrared images. Silicon cameras have much smaller intrinsic noise than their IR counter part- some models even offer near single photon detection capability. We demonstrate that an ordinary CCD camera combined with a low noise upconversion has superior noise characteristics when compared to even state-of-the art IR cameras..